obstruction. Does an incarcerated hernia require an operation? The requirements are more urgent, if it has become inflamed. Shall we cut through the inflamed tissues. Of the necessity of this I have no doubt. The patient will inevitably die, if we do not operate. We may save life, only we must be reasonably certain of our diagnosis. Exactly, what shall we do? Cut through the inflamed tissues down to the knuckle, or folds of intestine, contained in the hernial sac. This will deplete the engorged blood vessels; it will facilitate the removal of purulent infiltration; it will permit the application of disinfectants; and it will enable the surgeon to cut such adhesion bands as tend to cause strangulation,—and then one of three things may be done—reduction may be accomplished; exsection may be performed; or an artificial anus may be made. And in some cases the damaged intestine may be of necessity left where it is.

AN EXPERIMENTAL CONTRIBUTION TO INTESTINAL SURGERY WITH SPECIAL REFERENCE TO THE TREATMENT OF INTESTINAL OBSTRUCTION.[1]

(CONCLUDED.)

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9. Omental Grafting.

UNDER the head of circular enterorrhaphy mention is made of transplantation of omental flaps after uniting the two ends of the bowel by suturing or invagination with a view of securing an additional safeguard against perforation during the process of repair. A number of experiments are described where the procedure was practised with satisfactory results. After a few days the omental flaps were found firmly adherent and vascular around the whole circumference of the bowel constituting a ring of living tissue outside the line of suturing. In all these cases the proximal end of the flap remained in connection with the omentum, and care was taken to cut the flap in such a manner that some vessel of considerable size should furnish the necessary vascular supply. I was well aware that plausible objections could be entered against this method in that the connecting bridge between the bowel and the omentum might become subsequently a cause of intestinal obstruction by making traction upon the bowel, thus causing a flexion, or, by becoming a band of constriction for some loop of intestine. For the purpose of obviating such remote consequences I resorted to another procedure which I have designated as omental grafting. I was familiar with the fact that implantations of aseptic substances into the peritoneal cavity had frequently been done without any immediate or remote ill effects, and I had every reason to expect that a large, completely detached aseptic omental graft, in an aseptic abdominal cavity, would be well tolerated, and would soon become adherent to the subjacent peritoneal surface, and thus afford an additional safeguard against perforation and the disastrous consecutive result—perforative peritonitis during the time required for the healing of the intestinal wound. In the following experiments the grafts used were from one and a half to two inches in width, and of sufficient length to completely encircle the bowel. The free ends were made to project a few lines beyond the mesenteric attachment, and were fixed by two fine catgut sutures, each of which embraced the corresponding angles of the graft and the mesentery. The stitches were made in the direction of the mesenteric vessels, so that in tying, no vessel should be included in the suture. In these experiments dogs were used exclusively.

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[1] Read in the Surgical Section of the Ninth International Medical Congress, Washington, September 5, 1887.

Experiment 106.—Three pieces of omentum, two inches wide and sufficiently long to encircle the bowel, were completely detached and grafted as follows:

1. Graft simply laid over the bowel corresponding to the lower portion of the ileum and fastened in its place on mesenteric side by two fine catgut sutures.

2. Serous surface of bowel about 6 inches higher up scarified and graft applied to this surface and fixed in the same manner.

3. About six inches still higher up bowel treated in the same way, and one of the serous surfaces of the graft also freely scarified.

The graft was scarified on the side which was to be brought in contact with the bowel. Fixation of graft by two catgut sutures on mesenteric side. Animal killed 36 hours after operation. All the grafts adherent, slightly contracting the bowel at the three different places. On separating the adhesions the subjacent serous surface very vascular and denuded of its endothelial layer. Firmness of adhesions increases in proportion to the extent of scarification done, being least firm at No. 1, firmer at No. 2, and firmest at No. 3, where both coaptated serous surfaces had been scarified. At No. 2 and 3 the plastic lymph was freely supplied with new blood vessels. The vascularization was most conspicuous on the mesenteric side.

Experiment 107.—Two omental grafts planted around the ileum in the same manner as described above. At No. 1 both the bowel and the inner side of the graft were scarified; at No. 2, only the serous surface of the bowel. Animal killed 43 hours after operation. Stump of omentum adherent to abdominal wound and intestines. No peritonitis. At No. 1, graft firmly adherent over the entire extent. A slight extravasation of blood between the graft and the bowel. Beginning vascularization of interposed plastic lymph. At No. 2 also firm adhesions and beginning vascularization of the plastic exudation. Both of the grafts appear to be stained with the coloring material of the blood.

Experiment 108.—Planting of two omental grafts around the ileum about 8 inches apart. At No. 1 both the bowel and one side of the omental graft were scarified. At No. 2 only the serous surface of the bowel was treated in this manner. Animal killed six days after the operation. Both grafts firmly adherent throughout and freely supplied with blood vessels, the largest of the new vessels being on the mesenteric side. The omental stump adherent to the portion of bowel between the grafts where a flexion has been made from this cause.

Experiment 109.—In this experiment omental grafting was done at two points around the lower portion of the ileum. At one point the serous surfaces were left intact, at the other both the peritoneal surface of the bowel and the omental graft were freely scarified. Animal remained perfectly well and was killed 8 days after operation. No signs of peritonitis. Both grafts formed a thin vascular layer around the entire circumference of the bowel and firmly and evenly united throughout. Vascularization was more marked where scarification had been done. On attempting to separate the grafts it was difficult to find and define the line of union between the omentum and the underlying bowel as the union was very intimate and firm.

REMARKS.—In all of these experiments the grafts retained their vitality, and in a few hours became firmly adherent to the intestinal surface with which they had been brought in contact. Scarification of the serous surface has also been found in these experiments an exceedingly valuable measure in hastening the process of adhesion, granulation and vascularization. By planting grafts side by side, with and without scarification, I was enabled to determine with accuracy the beneficial influence exerted by this procedure in favoring the reparative process, and without a single exception observed that where scarification was done the adhesions were firmer and vascularization more advanced. The post-mortem examinations appeared to demonstrate that the firmness of the adhesions and the degree of vascularization were in direct proportion to the extent of traumatic irritation of the peritoneum, being always most marked in cases where both the bowel and the under surface of the graft were scarified, and least where intact peritoneal surfaces were brought into apposition. As soon as the omental grafts were cut off from the omentum they were placed in a 1:2000 solution of corrosive sublimate, kept at the temperature of the body in order to secure for the graft a perfectly aseptic condition, until everything was in readiness for the transfer of the graft to its new location. Before planting the graft it was carefully dried by pressing it between gauze or sponges wrung out of the same solution. The scarifications of the serous surfaces should only be made sufficiently deep to give rise to a very slight oozing, as when hemorrhage is more profuse there is danger of the formation of a clot between the graft and the bowel, which, if it does not ultimately prevent union between the coaptated surfaces, must necessarily interfere with the formation of early and firm adhesions. Omental grafting cannot fail in becoming an established procedure in many abdominal operations. After suturing a large wound of the stomach or intestines, a strip of omentum should be laid over the wound and fasted in its place by a few catgut sutures. After circular enterorrhaphy the operation should be finished by covering the circular wound by an omental graft about two inches wide, which should be fixed in its place by two catgut sutures passed through both ends of the graft and the mesentery. Omental grafting should also be resorted to in repairing peritoneal defects in visceral injuries of the abdominal organs, and in covering large stumps after ovariotomy or hysterectomy, where the pedicle is treated by the intra-abdominal method.

V. CONCLUSIONS.

In conclusion I beg leave to submit the following propositions for further discussion:

1. Traumatic stenosis from partial enterectomy and longitudinal suturing of the wound becomes a source of danger from obstruction or perforation in all cases where the lumen of the bowel is reduced more than one-half in size.

2. Longitudinal suturing of wounds on the mesenteric side of the intestine should never be practised, as such a procedure is invariably followed by gangrene and perforation by intercepting the vascular supply to the portion of bowel which corresponds to the mesenteric defect.

3. The immediate cause of gangrene in circular constriction of a loop of intestine is due to obstruction of the venous circulation, and takes places first in the majority of cases at a point most remote from the cause of the obstruction.

4. On the convex surface of the bowel a defect an inch in width, from injury or operation, can be closed by transverse suturing without causing obstruction by flexion. In such cases the stenosis is subsequently corrected by a compensating bulging, or dilatation of the mesenteric side of the bowel.

5. Closing a wound of such dimensions on the mesenteric side of the bowel by transverse suturing may give rise to intestinal obstruction by flexion, and to gangrene and perforation by seriously impairing the arterial supply to, and venous

return from, the portion of bowel corresponding with the mesenteric defect.

6. Flexion caused by inflammatory and other extrinsic causes gives rise to intestinal obstruction only in case the functional capacity of the flexed portion of the bowel has been impaired or suspended by the causes which have produced the flexion, or, by subsequent pathological conditions which have occurred independently of the flexion.

7. As in flexion, a volvulus gives rise to symptoms of obstruction when the causes which have given rise to a rotation upon its axis of a loop of bowel, have at the same time produced an impairment or suspension of peristalsis in the portion of bowel which constitutes the volvulus, or when a diminution or suspension of peristalsis follows in consequence of the degree or extent of the rotation.

8. Accumulation of intestinal contents above the seat of invagination is one of the most important factors which prevents spontaneous reduction, and which determines gangrene of the intussusceptum and perforation of the bowel.

9. Spontaneous disinvagination is not more frequent in ascending than descending invagination.

10. The immediate or direct cause of gangrene of the intussusceptum is obstruction to the return of venous blood by constriction at the neck of the intussuscipiens.

11. Ileo-cæcal invagination, when recent, can frequently be reduced by distention of the colon and rectum with water, but this method of reduction must be practised with the greatest caution and gentleness, as over-distention of the colon and rectum is productive of multiple longitudinal lacerations of the peritoneal coat, an accident which is followed by the gravest consequences.

12. The competency of the ileo-cæcal valve can only be overcome by over-distention of the cæcum, and is effected by a mechanical separation of the margins of the valve, consequently it is imprudent to attempt the treatment of intestinal obstruction beyond the ileo-cæcal region by injections per rectum.

13. Resection of more than six feet of the small intestine in dogs is uniformly fatal, the cause of death in such cases is

always attributable to the immediate effects of the trauma.

14. Resection of more than four feet of the small intestine in dogs is incompatible with normal digestion, absorption and nutrition, and often results in death from marasmus.

15. In cases of extensive intestinal resection the remaining portion of the intestinal tract undergoes compensatory hypertrophy which macroscopically is apparent by thickening of the intestinal coats and increased vascularization.

16. Physiological exclusion of an extensive portion of the intestinal tract does not impair digestion, absorption and nutrition as seriously as the removal of a similar portion by resection.

17. Fæcal accumulation does not take place in the excluded portion of the intestinal canal.

18. The excluded portion of the bowel undergoes progressive atrophy.

19. A modification of Jobert's invagination suture by lining the intussusceptum with a thin flexible rubber ring, and the substitution of catgut for silk sutures is preferable to circular enterorrhaphy by the Czerny-Lembert suture.

20. The line of suturing, or neck of intussuscipïens, should be covered by a flap or graft of omentum in all cases of circular resection, as this procedure furnishes an additional protection against perforation.

21. In circular enterorrhaphy the continuity of the peritoneal surface of the ends of the bowel to be united should be procured where the mesentery is detached by uniting the peritoneum with a fine catgut suture before the bowel is sutured, as this modification of the ordinary method furnishes a better security against perforation on the mesenteric side.

22. In cases of complete division of an intestine, if it is deemed advisable not to resort to circular enterorrhaphy, one or both ends of the bowel should be closed by invagination to the depth of an inch, and three stitches of the continued suture embracing only the peritoneal and muscular coats.

23. The formation of a fistulous communication between the bowel above and below the seat of the obstruction should take the place of resection and circular enterorrhaphy in all cases where it is impossible or impracticable to remove the

cause of obstruction, or, where after excision it would be impossible to restore the continuity of the intestinal canal by suturing, or where the pathological conditions which gave rise to the obstruction do not constitute an intrinsic source of danger,

24. The formation of an artificial anus in the treatment of intestinal obstruction should only be practised in cases where continuity of the intestinal canal cannot be restored by making an intestinal anastomosis.

25. Gastro-enterostomy, jejuno-ileostomy and ileo-ileostomy should always be made by lateral apposition with partially or completely decalcified perforated bone plates.

26. In making an intestinal anastomosis for obstruction in the cæcum, or colon, the communication above and below the seat of obstruction can be established by lateral apposition with perforated approximation plates, or by lateral implantation of the ileum into the colon or rectum.

27. An ileo-colostomy, or ileo-rectostomy by approximation with decalcified, perforated bone plates, or by lateral implantation should be done in all cases of irreducible ileo-cæcal invagination, where the local signs do not indicate the existence of gangrene or impending perforation.

28. In all cases of impending gangrene or perforation, the invaginated portion should be excised, both ends of the bowel permanently closed, and the continuity of the intestinal canal restored by making an ileo-colostomy or ileo-rectostomy.

29. The restoration of the continuity of the intestinal canal by perforated approximation plates, or by lateral implantation, should be resorted to in all cases where circular enterorrhaphy is impossible on account of the difference in size of the lumina of the two ends of the bowel.

30. In cases of multiple gunshot wounds of the intestines involving the lateral or convex side of the bowel, the formation of intestinal anastomosis by perforated decalcified bone plates should be preferred to suturing, as this procedure is equally, if not more, safe, and requires less time.

31. Definitive healing of the intestinal wound is only initiated after the formation of a network of new vessels in the product of tissue proliferation from the approximated serous surfaces.

32. Under favorable circumstances quite firm adhesions are found within the peritoneal surfaces in six to twelve hours which effectually resist the pressure from within outward.

33. Scarification of the peritoneum at the seat of coaptation hastens the formation of adhesions and the definitive healing of the intestinal wound.

34. Omental grafts, from one to two inches in width, and sufficiently long to completely encircle the bowel, retain their vitality, become firmly adherent in from 12 to 18 hours, and are freely supplied with blood vessels in from 18 to 48 hours.

35. Omental transplantation, or omental grafting, should be done in every circular resection, or suturing of large wounds of the stomach or intestines, as this procedure favors healing of the visceral wound, and affords an additional protection against perforation.

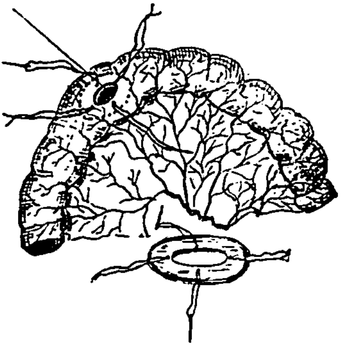
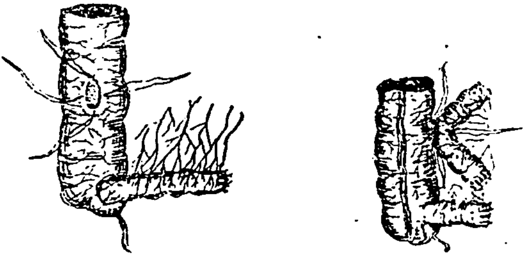


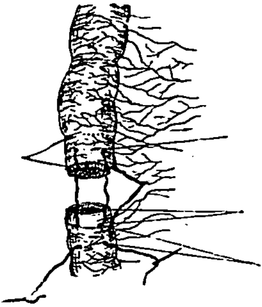
Plate within the intestine above seat of obstruction.
Perforated decalcified bone plate.



INTESTINAL ANASTOMOSIS BY PERFORATED DECALCIFIED BONE-PLATES.

Plate within colon below seat of obstruction.

Approximation of intestine by tying of sutures.



Rubber ring within bowel fixed by continuous catgut sutures.
Needles passed from within outward through entire wall of bowel and ring.
Part to be invaginated.
Needles passed through serous and muscular coats.

AUTHOR'S MODIFICATION OF JOBERT'S SUTURE.

PLATE. I—METHODS OF INTESTINAL ANASTOMOSIS.